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FEDERAL COMMUNICATIONS COMMISSION OFFICE OF SECRETARY

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JILL A. STERN (202) 663-8380

July 25, 1994

Mr. William F. Caton Acting Secretary Federal Communications Commission 1919 M Street, N.W. Room 222 Washington, D.C. 20554

Re: GEN Docket No. 90-314

Dear Mr. Caton:

On behalf of Spatial Communications, Inc. and ArrayComm, Inc., I am transmitting herewith an original and eleven copies of their "Petition for Further Reconsideration and Request for Clarification" in the above-referenced proceeding.

Should there be any questions concerning this matter, kindly communicate with the undersigned.

Sincerely,

Jill\Abeshouse Stern

Counsel to Spatial Communications, Inc. and ArrayComm, Inc.

il Obehouse Stein

Enclosures

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RECEIVED NUL 2 5 1994

Before The FEDERAL COMMUNICATIONS COMMISSION FEDERAL COMMUNICATIONS COMMISSION Washington, D.C. 20554 FEDERAL COMMUNICATIONS COMMISSION OFFICE OF SECRETARY

In the Matter of)		
)		
Amendment of the)	Gen Docket No.	90-314
Commission's Rules to	j		
Establish New Personal	j		
Communications Services)		

PETITION FOR FURTHER RECONSIDERATION AND REQUEST FOR CLARIFICATION

ArrayComm, Inc. ("ArrayComm") and Spatial Communications, Inc. ("SCI"), by their attorneys and pursuant to Commission Rule 1.429, seek reconsideration of the Memorandum Opinion and Order in the above-captioned proceeding which amended certain aspects of the rules governing broadband personal communications services (PCS). $\frac{1}{2}$

I.

SCI and its parent company, ArrayComm, are the developers of the innovative Spatial Division Multiple Access ("SDMA") technology. SDMA uses patented algorithms to implement "smart antennas" that track mobile users and selectively direct RF energy toward the intended receivers. Directional transmission and reception using smart antennas provide significant public benefits including increased spectrum efficiency and reduced PCS implementation costs. Perhaps most importantly, directional

 $[\]frac{1}{2}$ 59 Fed. Reg. 32830 (June 24, 1994).

transmission and reception offer the most effective and efficient means of increasing coverage area, from an economic, technical and public interest standpoint.

On April 22, 1994, ArrayComm and SCI filed joint comments in support of the December 8, 1993 "MCI Petition for Partial Reconsideration and Clarification" and the "Petition for Reconsideration" of Telocator, The Personal Communications Industry Association ("PCIA") with respect to the Second Report and Order in the broadband PCS proceeding. In their comments, ArrayComm and SCI agreed with PCIA, MCI and others in the industry that increases in base station power limits are critical to the viability of PCS.

Although generally supporting increased base station power levels, SCI and ArrayComm offered an approach that would more fully achieve the Commission's stated objective of facilitating the use of directional antennas. In their April 22, 1994 comments, SCI and ArrayComm set forth proposed rules incorporating the concepts of peak directional radiated power and average radiated power from PCS base stations. Under this approach, higher power is permitted by concentrating a smaller amount of total radiated power toward the intended user. The proposed power limits are designed to ensure public safety and encourage directional transmission while allowing for omnidirectional transmission if the licensee so chooses.

The SCI/ArrayComm proposal reflected discussions with the PCS Task Force on April 5, 1994, a presentation to PCIA, and subsequent discussions with PCIA members leading to refinements of the proposal which were submitted on May 9, 1994 to the Commission. $\frac{2}{}$

A copy of the joint SCI/ArrayComm comments, which contain a detailed technical proposal and proposed rules, is attached as Exhibit A. Among other things, Exhibit A provides formulae (and tables) for calculating the permissible average and peak directional radiated powers. Adoption of these standards will provide flexibility to PCS licensees and facilitate use of smart antenna technology by those operators who wish to do so.

II.

In the Memorandum Opinion and Order, released June 13, 1994, the Commission increased the maximum base station power limit to 1640 watts e.i.r.p. and amended PCS power HAAT coordination distance requirements in order to improve PCS licensees' ability to configure their systems to best serve the needs of their customers and compete with other mobile services. The Commission noted that this change will also "facilitate the use of new

The joint comments attached as Exhibit A have been conformed to include the revised technical proposal submitted on May 9, 1994. It is noteworthy that the proposal met with broad approval among PCIA members, including both manufacturers and operators.

technologies, such as high-gain, directional antennas." $\frac{3}{}$ According to the Commission, the decision to limit transmitter output power of the base station to 100 watts per channel was also intended to promote the use of high-gain directional antennas.

Although the Commission's stated intention was to promote use of directional antennas, it apparently failed to consider the joint comments previously submitted by SCI and ArrayComm in April 1994 which set forth a detailed technical proposal on this very issue. The SCI/ArrayComm proposal represented a substantial amount of technical work and evidenced the companies' efforts to develop appropriate rules in cooperation with Commission Staff and industry members that will facilitate the break-through (and publicly beneficial) smart antenna technology.

Despite this, it appears that the SCI/ArrayComm joint comments were not considered by the Commission in the Memorandum Opinion and Order. There is no reference to the SCI/ArrayComm comments in either the text of the Order or the list of parties in Appendix B. This omission requires the Commission to grant further reconsideration, at a minimum, for the purpose of

^{3/} Id. at para. 172.

considering and incorporating the SCI/ArrayComm proposal for PCS power limitations. $\frac{4}{}$

III.

Although the Commission has expressed an intention to facilitate the use of directional antennas, the revised rules do not achieve the intended purpose. Rather than facilitate directional antennas, the revised rules may, in fact, inadvertently discourage use of such antennas. As SCI/ArrayComm sought to demonstrate in its previously submitted comments, highly directional or smart antennas are an innovative technology that cannot be regulated according to standard "one-dimensional" power definitions. The limitations of standard power definitions is apparent in the revised rules.

For example, the revised power limits are stated in terms of watts per channel (rather than watts/Hz). This encourages the use of narrower channels and therefore favors the use of narrowband RF channels over wide-band channels, contrary to the Commission's stated intention of neutrality with respect to modulation format. In contrast, the SCI/ArrayComm proposal treats all modulation formats equitably in that each has an equal

See Rule 1.425 ("The Commission will consider all relevant comments and material of record before taking final action in a rulemaking proceeding and will issue a decision incorporating its finding and a brief statement of the reasons therefor.")

opportunity to achieve the maximum information transmission rate possible (consistent with RF radiation guidelines.)

In addition, by maintaining a power limit of 100 watts per channel on the base station transmitter, the Commission may have inadvertently discouraged the use of smart antenna technology. The use of highly directional antenna technology combined with low transmitter power limits will preclude large coverage areas by restricting the "broadcast" control channels that are fundamental for wireless communication protocols and will determine the ultimate size of the coverage area.

For these reasons, the approach proposed by SCI/ArrayComm will more effectively accomplish the Commission's objective of facilitating the use of directional antennas and allowing for maximum licensee flexibility.

IV.

While SCI/ArrayComm believe that the proposed PCS power limitations, set forth in Exhibit A, will facilitate use of highly directional antennas and should be adopted, the Commission must, in any event, clarify the transmitter power limitations set forth in the current rules (100 watts per channel) to ensure that these limits do not inadvertently discourage smart antenna technology contrary to the Commission's intention. The Commission should clarify that the limits apply to individual base station transmitters without regard to the number of such

transmitters employed at each base station, the antenna element or elements to which each transmitter is connected, or the channels in which each transmitter is allowed to transmit. $\frac{5}{}$

This interpretation is consistent with the Commission's intention to facilitate use of directional antennas and with the language of the revised rules. To avoid an inconsistent interpretation that would unfairly impact upon use of new technologies, like smart antennas, this clarification should be provided.

٧.

For the foregoing reasons, SCI and ArrayComm urge the Commission to grant further reconsideration and revise the PCS power limitations adopted in the Memorandum Opinion and Order by adopting an approach that incorporates the concepts of peak directional power and average radiated power as more fully set forth in Exhibit A hereto. This approach will achieve the Commission's stated objective of facilitating the use of highly directional smart antennas by allowing for maximum licensee and

In other words, it is acceptable for more than one base station transmitter to transmit 100 watts of power in the same RF channel at the same time as long as different antenna elements are used for each transmitter, i.e., power level as measured at the input to an antenna element.

manufacturer flexibility. The Commission should, at a minimum, clarify how the transmitter limitations adopted in the Memorandum Opinion and Order will be applied to multiple transmitter, multiple antenna element base stations.

Respectfully submitted,

SPATIAL COMMUNICATIONS, INC. ARRAYCOMM INC.

Jill Abeshouse Stern Shaw, Pittman, Potts &

Trowbridge

2300 N Street, N.W. Washington, D.C. 20037

202/663-8380

Their Attorneys

July 25, 1994

EXHIBIT A

Before the FEDERAL COMMUNICATIONS COMMISSION Washington, D.C. 20554

In the Matter of					
)				
Amendment to the Commission's)	GEN	Docket	No.	90-314
Rules to Establish New Personal)				
Communications Services)				

JOINT COMMENTS OF SPATIAL COMMUNICATIONS, INC. AND ARRAYCOMM, INC.

Spatial Communications, Inc.("SCI") and ArrayComm, Inc.
("ArrayComm"), by their attorneys, hereby submit joint comments
in the above-captioned proceeding. These comments are filed in
support of the December 8, 1993 "MCI Petition for Partial
Reconsideration and Clarification" and the "Petition for
Reconsideration" of Telocator, The Personal Communications
Industry Association ("PCIA"), of the Second Report and Order in
GEN Docket No. 90-314. These comments are also submitted in
response to the hearings held on April 11 and 12, 1994 by the PCS
Task Force, and the views expressed therein.

I.

SCI and it parent company, ArrayComm, are the developers of the innovative Spatial Division Multiple Access ("SDMA") technology. SDMA relies upon patented algorithms to implement "smart antennas" that track mobile users and selectively direct RF energy toward the intended receivers. Directional

transmission and reception using smart antennas provides significant public benefits including increased spectrum efficiency, reduced costs of implementing and providing PCS services, reduced RF interference and radiation exposure, and inherent 911 emergency location services.

The technical feasibility and public benefits of SDMA technology have been confirmed by independent technical experts and by diverse government entities, including the Advanced Research Projects Agency which recently awarded a Technology Reinvestment Project (TRP) grant to ArrayComm for further development of SDMA technology. 1/2 In addition, experimental testing under actual field conditions, using prototype equipment, has demonstrated the technical feasibility of SDMA technology.

II.

In these comments, SCI and ArrayComm focus on a critical issue that was raised in the MCI, PCIA and other industry petitions, and largely overlooked in the Task Force hearings. This issue can be simply stated: large-scale PCS implementation will not be economically feasible unless permissible cell size is increased. SCI and ArrayComm believe that directional

Affidavits of technical experts have been previously submitted in this proceeding, and are resubmitted herewith for the Commission's convenience. In addition, letters supporting ArrayComm's TRP filing are also submitted herewith in Exhibit 1.

transmission and reception offer the most effective and efficient means of increasing coverage area -- from an economic, technical and public interest standpoint. Numerous operators and manufacturers share this view.

Directional transmission and reception, such as demonstrated by ArrayComm, offers operators the ability to improve service quality and increase user capacity, while reducing the cost of service to the public. $\frac{2}{}$ As a practical matter, smart antennas are the means of harmonizing the industry's objectives of increased power (larger coverage areas and increased capacity) with the Commission's interests in minimizing interference and reducing radiation exposure.

Among other benefits, use of smart antennas significantly increases the number of channels that a base station can serve, by reducing the required amount of transmitted power from both the base stations and the mobile units, overcoming multiple signal reception problems, and by allowing multiple users to occupy the same frequency, time slot or code at the same time. Directional transmission can be used to minimize interference throughout the system, including problems associated with fixed microwave users in the same band. Moreover, directional transmission reduces radiation risks.

^{2/} Attached hereto as Exhibit 2 is information demonstrating the potential cost savings to the operator.

While SCI and ArrayComm believe that directional transmission and reception should be required as a basic PCS system architecture, at a minimum, the Commission should facilitate the use of smart antennas by refining the power limitations for PCS systems as more fully discussed below and in the associated technical exhibit. $\frac{3}{}$

III.

In their petitions, PCIA and MCI requested that the Commission authorize an increase in base station EIRP limits from 100 W to 1600 W, in order to facilitate use of "smart antenna" concepts. 4/ These petitioners state that, while mobile units are limited to 2 W EIRP average, "smart antenna" technology could be used to balance the links if 1600 W base station EIRPs were allowed. Furthermore, the petitioners point out that the larger coverage areas afforded by the higher base station EIRPs are necessary for the commercial viability of PCS.

SCI and ArrayComm agree with this industry assessment that increases in base station power limits are critical to the viability of PCS. While generally supporting the proposals of

The second-generation SDMA processor under development by ArrayComm will apply to all proposed PCS air-interface standards, both analog and digital. The logarithms and hardware configuration could be incorporated by any manufacturer, regardless of RF modulation format, desiring to utilize this break-through technology.

^{4/} See, e.g., PCIA Petition at 3-4; MCI Petition at 6-8.

PCIA, MCI and others, SCI and ArrayComm believe that the public interest would be best served by adopting an approach that combines the concept of peak directional radiated power and average radiated power.

Under this approach, higher power would be permitted by concentrating a smaller amount of total radiated power toward the intended user, not through omnidirectional transmission. Even though the power would be directed toward users, currently accepted RF exposure standards would be met as shown in the attached technical exhibit.

To assist the FCC in developing appropriate guidelines to facilitate the use of directional transmission, a detailed technical discussion is provided in the attached exhibit. ⁵/ In the technical exhibit, modifications to the standard definitions commonly used by the Commission are proposed to facilitate use of directional transmission, while ensuring that maximum RF exposure is well below accepted limits. The exhibit provides tables for calculating the permissible average and peak directional radiated powers. The Commission should adopt these standards in order to provide flexibility to PCS licensees, ensure that RF exposure

It bears emphasis that the current power limitations adopted in this proceeding do not preclude smart antennas or SDMA technology. However, these power limitations do not allow operators to achieve the full economic (and public) benefits offered by this technology because of the limited coverage area now permitted. The rule changes proposed herein would encourage use of directional transmission and reception, and facilitate use of this innovative and spectrally-efficient technology.

guidelines as adopted by the Commission are met, and facilitate use of smart antenna technology by those operators and manufacturers who wish to do so.

Conclusion

SCI and ArrayComm support the petitions of PCIA, MCI and others urging the Commission to revise the proposed power limitations for PCS systems in order to ensure expeditious deployment of cost-effective and high-quality PCS service. To facilitate use of smart antennas, and the public benefits they will provide, SCI and ArrayComm recommend that the Commission adopt power limitations that combine the concept of total radiated power and peak radiated power as more fully set forth in the associated technical exhibit.

Respectfully submitted,

SPATIAL COMMUNICATIONS, INC. ARRAYCOMM, INC.

By:

1 Abeshouse Stern

SHAW, PITTMAN, POTTS & TROWBRIDGE

2300 N Street, N.W. Washington, D.C. 20037

(202) 663-8000

Their Attorney

April 22, 1994

Exhibit 1

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Cital Canada Exercise Direct Corporate Strategy-Technology

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A Pecific Yeleols Company

March 31, 1994

Dr. Richard H. Roy President Arraycomm 3255 Scott Blvd. Blog. 4, Suite 103 Santa Clara, Ca. 95054-3013

Deer Richard.

I would like to thank you for the opportunity to view your field demonstrations of

I was very impressed with progress Arraycomm has made over the past year, especially in the area of range enhancement and capacity solutions for the 1900 MHz band. In general, AirTouch believes that exploitation of the spatial domain by use of intelligent array entennas will be a key enabling technology for new wireless infrastructure deployments.

AirTouch supports the efforts of Arraycomm that aim to reduce infrastructure costs through range and capacity enhancements offered by SDMA techniques.

Please keep me informed of your progress.

Sincerely.

Executive Director - Technology Strategy

AirTouch Communications, Inc.



Eric F. Ensor
Assistant Vice President
Worldwide Wireless Strategy

July 21, 1993

Room 8D01 1100 Peachtree Street, NE Atlanta, Georgia 30309 (404) 249-4375 (404) 249-4488 Fax

Mr. Martin Cooper Chairman and CEO ArrayComm, Inc. 3225 Scott Blvd., Bldg. 4 Santa Clara, CA 95054-3013

re: BellSouth's PCS development and ArrayComm's SDMA technology

Dear Marty:

Thank you for the hospitality you extended to the members of our organization that visited your facility recently. They were impressed by the demonstration of SDMA technology you presented. It reinforces our belief that smart antenna technology such as SDMA will play a significant role in wireless communication systems of the future.

As you are aware, we are in the process of planning a next generation (PCS) wireless system which we will be developing over the course of the next several years. We would like to take this opportunity to inform you of some decisions made within our organization in this regard. It is our intent to work closely with several major telecommunication manufacturers and operators for the design, development and manufacture of a PCS network to operate in the 1800 MHz band. Among various other technical requirements we expect the companies to meet will be that of provisions for inclusion of smart antenna technology. We view SDMA's potential for increasing signal quality, lowering mobile-unit transmitter powers, protecting incumbent microwave users in the band of interest, and increasing coverage area as important assets in providing us the flexibility to design a cost-effective PCS network which meets the needs of our customers. In an effort to accelerate the development of this technology, we are encouraging manufacturers to enter into discussions with companies such as ArrayComm.

We are looking forward to working closely with all our developers and suppliers in developing a high-quality wireless network which will allow our organization to maintain its leadership position in this exploding worldwide marketplace.

Sincerely,

Eric Ensor

Er Cun

300 North Wiget Lane, Suite 100 Walnut Cores, California, 14588-2406 (510) 10-4800 Eux (510) 10-3806



A Pacific Telesis Company

July 23, 1993

Mr. Martin Cooper Chairman and CEO ArrayComm, Inc. 3225 Scott Blvd., Bldg. 4 Santa Clara, Ca 94054-3013

Dear Martin,

I would like to take this opportunity to thank you for arranging this weeks meeting at your facility. The demonstration conducted by your team of SDMA technology was quite impressive.

As you know, Telesis Technologies Laboratory is investigating Personal Communication Services (PCS) for both Pacific Telesis business units (Pacific Bell and PacTel Corporation). From your demonstration it appears that the application of SDMA technology in new PCS networks could be very promising.

We are having internal discussion in our organization on the development of PCS technologies and will be discussing SDMA and its potential application.

Again, I want to thank you for the demonstration. I look forward to a continuing dialog with you on the direction and development of your SDMA technology.

Best Regards,

Limond Grindstaff Executive Director

LG/bmc

Raytheen

20 July 1993

Dr. Richard H. Roy President, ArrayComm, Inc. 3255 Scott Blvd. Bldg. 4 Santa Clara, CA 95054-3013

Dear Dr. Roy:

Raytheon has been briefed by ArrayComm regarding their SDMA technology for wireless telecommunications.

We believe that the proposal by your team can enhance the cellular telephone industry. As you know, Raytheon, TRW, Honeywell, NASA and USAF have formed the Signal Processing Consortium for producing broadband modules for 21st Century Digital Telecommunication markets such as yours. It is the intent of our Consortium to work closely with your company, thus ensuring U.S. leadership in this pervasive technology area.

Raytheon is interested in maintaining contact with ArrayComm and would like to support the development of your SDMA technology for applications in the international telecommunication market.

Sincerely, Dussey



Mobile Communications Centre 32 avenue Kléber 92707 COLOMBES CEDEX France

Ref

CD/kr/93.538

Date

16/07/93

Claude Déchaux

tel. +33 (1) 46.52.12.06 fax. +33 (1) 46.52.80.17

> Mr. Martin Cooper Chairman and CEO ArrayComm, Inc. 3255 Scott Blvd, #4-103 Santa Clara, CA 95054

Dear Marty

I would like to thank you for your hospitality during my recent visit to your facility. The demonstration of your SDMA technology was highly interesting.

We at Alcatel believe that smart antenna technology such as SDMA will play an important role in future wireless communication systems.

I would also like to take this opportunity to inform you that, as Alcatel is aggressively pursing major cellular and PCS opportunities worldwide, several companies in the Alcatel group will contact you in the near future to discuss possible integration of ArrayComm's technology into their products and systems.

In particular the application of SDMA technology to the enhancement of performances of DCS 1800 systems seems very appropriate and would speed up their acceptance in the worldwide market.

Yours sincerely

C Déchaux

Director of Strategy

Mobile Communications Business

Dechan

AFFIDAVIT

- I, Guy Jouannelle do hereby declare as follows:
- 1. I am currently Senior Engineer of LCC LLC and have held my current position for 1 year.
- I have more than 11 years experience in the design and development of telecommunications systems Previous positions include the following:
- Research Engineer of ONERA (France), responsible for anisons arrays conception, design and
- experimentation, and propagation modeling.

 Project Manager at Alcaial Radiotal-phone (France), for radio engineering tool development.

 Director of Tachnical Development at France Telecom, responsible for all technical aspects of a GSM National Network Radio Engineering and Deployment
- associated radio engineering tools development. my ourrest position. I am responsible for supervising PCS technologies trends analysis and
- F. ArmyComm's SDMA technology and witnessed field demonstrations thereof. my capacity as Senior Engineer of LCC, I have reviewed theoretical and practical bases of
- On the basis of my review of the relevant literature and observations, it is my expert opinion that substantial increase in apactral affiniency. In the context of PCS, deployment of SDMA technology reception by base stations, and will allow multiple wireless links to there the same spectrum in the link to establish reliable communications through directional transmission from and directional increasing spectral efficiency. Deployment of SDMA technology will substantially reduce the will facilitate more efficient use of available spectrum for all service providers. same cell. The benefits include lower power handset and base station RF transmissions, and a amount of radiated (RF) power (over current technologies and for the same cell size) required per ArrayComm's SDMA technology is technically feasible and represents a truly innovative approach to

Under penalty of perjury, the foregoing is true and correct to the best of my knowledge

PH 251

X E

Sign

Tide

Scalet Engineer 30 March, 1994

AFFIDAVIT

- I. Stuart Jeffery do hereby declare as follows:
- 1. I am currently Vice President of Kycom, and have held my current position for over one year.
- 2. I am a duly qualified engineer, whose qualifications are a matter of record before the Federal Communications Commission. I hold the following degrees:

BS Physics, Ohio State University
Graduate Studies in Electrical Engineering, University of Colorodo
Exective MBA, Northeastern University

I hold a First Class FCC Radiotelephone License.

I have more than 25 years experience in the design and development of telecommunications systems. Previous positions include the following:

Director of Network Systems, GTE Corporation, Waltham, MA. Director of EW Systems, GTE Corporation, Mt View, CA. Manager of ESM Systems, ERA, a division of E-Systems, Reston, VA. Research Physicist, NBS, Boulder, CO. Assistant Chief Engineer, Ohio State University Telecommunications Center, Columbus, OH.

- 3. In my current position, I am responsible for supervising the design and development of Kycom's PCS telecommunications network.
- 4. In my capacity as Vice President of Kycom, I have fully reviewed the theoretical and practical bases of ArrayComm's SDMA technology and witnessed field demonstrations thereof.
- 5. On the basis of my review of the relevant literature and first-hand observations, it is my expert opinion that ArrayComm's SDMA technology is technically feasible and represents a truly innovative approach to increasing spectral efficiency. Deployment of SDMA technology will substantially reduce the amount of radiated (RF) power (over current technologies) required per link to establish reliable communication through directional transmission from and directional reception by base stations, and will allow multiple wireless links to share the same spectrum in the same cell. The benefits include lower power handset and base station RF transmissions, and a substantial increase in spectral efficiency. In the context of PCS, deployment of SDMA technology will facilitate more efficient use of available spectrum for all service providers, in addition to alleviating some of the OFS coexistence issues by substantially reducing contemplated exclusion zones.

Under penalty of perjury, the foregoing is true and correct to the best of my knowledge.

Kycom

Name Stuart S. Jeffery

Sign June Tullium

Title Vice President of Engineering, Kycom

Date March 29, 1994